SNL-CTBT-0007

Test Procedures for the INFRASOUND Prototype

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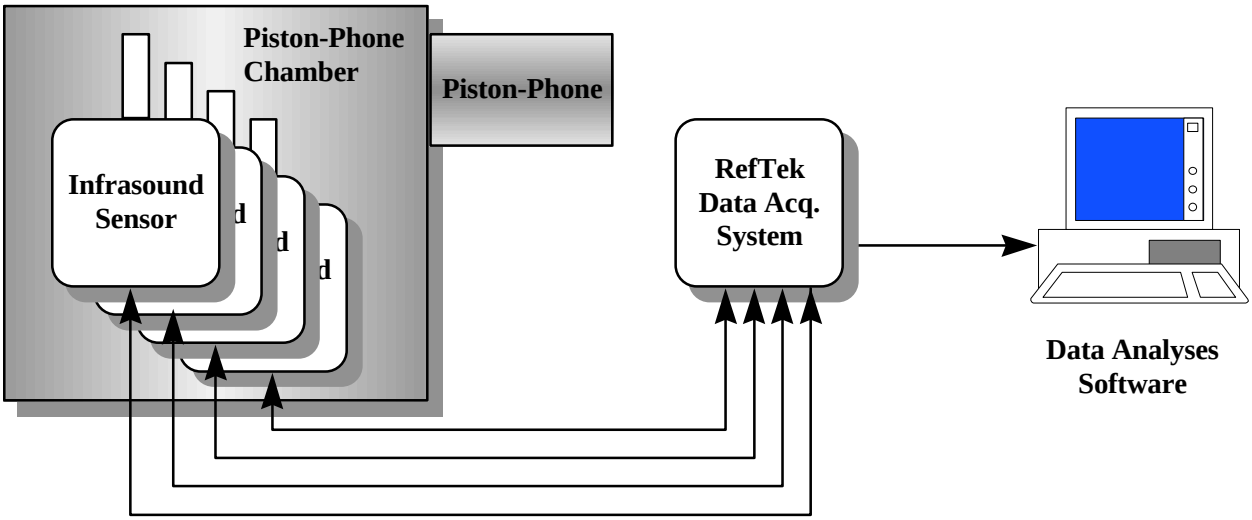
This document contains specific tests and corresponding procedures to be performed during the Infrasound Prototype acceptance testing to ensure compliance with the System Requirements Document.

Test Procedure 3.1.1 T

Requirement Tested

Wideband microbarograph with a flat frequency response from 0.02 to 5.0 Hz.

Setup



1. Place the infrasound sensors in the Piston-Phone Chamber as shown above.
2. Connect sensors to a RefTek Data Acquisition System.

Input

Sensor input should be open to the chamber.

Procedure

1. Record 32,000 samples of quiet background data from each sensor at 20 sps.
2. Compute and plot the coherence derived noise spectrum for each sensor.
3. Measure the frequencies at the lower and upper 3 dB points.
4. Using the Piston Phone, record at least 10 cycles of data for a low, mid and high frequency calibration at 40 sps for each sensor.
5. Fit a sine wave to each recorded frequency for each sensor.
6. Measure the amplitude at each frequency for each sensor.

Output

1. Lower frequency and the upper frequency 3 dB points for each sensor.
2. Amplitudes at the low, mid, high frequency for each sensor.

Evaluation

1. Lower 3 dB frequency is < 0.02 Hz and the upper 3 dB frequency is > 5.0 Hz
2. Amplitudes at the low, mid, high frequency for each sensor are within 10%.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.1.2 T

Requirement Tested

Resolution - 0.01 Pa at 1.0 Hz.

Setup

As in Test Procedure 3.1.1

Input

Sensor input should be open to the chamber.

Procedure

1. Calculate the resolution of 0.01 Pa at 1 Hz as in the memo Tim McDonald to Dale Breding dated 1 May 1997.
2. Convert the quiet background noise to the units of Pa.
3. Plot both on a single plot for each sensor.

Output

Plot of resolution and quiet background noise in Pa for each sensor.

Evaluation

Resolution value is greater than quiet background noise in Pa at 1.0 Hz for each sensor.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.1.3 I

Requirement Tested

Sensor should include noise reduction hoses.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect layout for noise reduction hoses.

Output

Noise reduction hoses are installed.

Evaluation

Noise reduction hoses are installed.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.1.4 T

Requirement Tested

Dynamic range should be at least 80 dB.

Setup

As in Test Procedure 3.1.1

Input

Sensor input should be open to the chamber.

Procedure

Calculate the Maximum Potential Dynamic Range (MPDR) for each sensor as follows:

1. From the quiet background noise data in Test Procedure 3.1.1, calculate the RMS value for the quiet background noise from 0.02 to 5.0 Hz for each sensor.
2. Calculate the RMS value of the maximum sine wave that can be produced by the sensor.
3. MPDR is the ratios of 2 to 1 above for each sensor.

Output

MPDR ratio.

Evaluation

MPDR is greater than 80 dB for each sensor.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.1.5 I

Requirement Tested

The analog full scale signal output shall be +/- 2 volts to +/- 10 volts.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Inspect the specifications for the infrasound sensor.
2. Observe the full scale voltage output.

Output

Full scale voltage output

Evaluation

Full scale voltage output is between +/- 2 volts to +/- 10 volts.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.1.6 I

Requirement Tested

Provide (sensor) documentation to include operations manual, schematics, parts and replacement list to enable repair to the component level.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Inspect documentation delivered by the sensor vendor.
2. Documentation should include operations manual, schematics, parts and replacement list to enable repair to the component level.

Output

Documentation includes operations manual, schematics, parts and replacement list to enable repair to the component level.

Evaluation

Documentation includes operations manual, schematics, parts and replacement list to enable repair to the component level.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.1.7 D

Requirement Tested

Provide the instrument response in ‘s’ plane pole and zero format.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Calculate the step response from the transfer function.
2. Measure the sensor step response from a step calibration signal.
3. Compare the calculated step response with the measured step response for the sensor.

Output

Calculated and measured step response.

Evaluation

Calculated and measured step responses compare favorably.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.1 D

Requirement Tested

Receive one channel of analog data from an infrasound sensor.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Demonstrate that one channel of analog data from each infrasound sensor is received at the receiving station by displaying the trace on the PC.

Output

One channel of infrasound data is displayed from each infrasound sensor.

Evaluation

One channel of infrasound data is displayed from each infrasound sensor.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.2 T

Requirement Tested

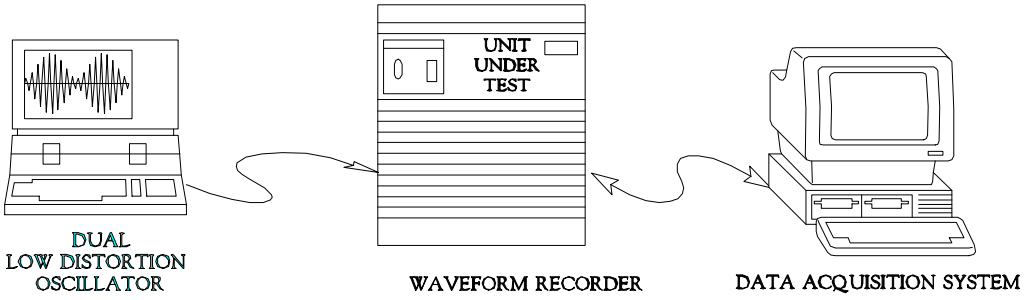
Digitize signal with at least a 20-bit resolution analog-to-digital converter (ADC).

Reference

Test Procedures (TP) for Seismic Waveform Recorder/High Resolution Digitizer Evaluation, V1.05, dated August 9, 1995

Setup

The SWR/HRD inputs are connected to a dual-tone ultra-low-distortion oscillator.



Instrumentation Required:

Chesapeake Sciences ULDO-901/s Ultra-Low-Distortion Oscillator or equivalent.

Input

Set the frequency and amplitude of the first oscillator to approximately the full scale (20 V peak to peak @ 1.02 Hz) of the digitizer. Set the frequency and amplitude of the second oscillator to the specified resolution (20 µV peak to peak @ 3.41 Hz) of the digitizer. Verify the amplitudes on the dual-tone ultra-low-distortion oscillator per Signal Source Performance Verification Procedure 6.2.2.

Procedure

Execute Reference Test Procedure 2.1.2 - Connect the dual-tone ultra-low-distortion oscillator to the HRD under test. Record and process at least 18,000 samples of each channel.

Output

1. Power density spectrum plot for each channel.
2. Observe the difference in the two amplitudes.
3. Difference in amplitudes should be 120 dB (i.e., 20 bit resolution).

Evaluation

Signal is digitized with at least a 20-bit resolution analog-to-digital converter (ADC).

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.3 D

Requirement Tested

Digitize signal to provide a data stream at a sample rate of 10 samples per second (sps).

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Demonstrate that the signal is digitized at a sample rate of 10 sps by displaying the 4 infrasound channels on the PC at a time scale (1 to 5 seconds) sufficient to display each sample.
2. Count the number of samples from one second to the next.

Output

Should be 10 sps.

Evaluation

Should be 10 sps.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.4 T

Requirement Tested

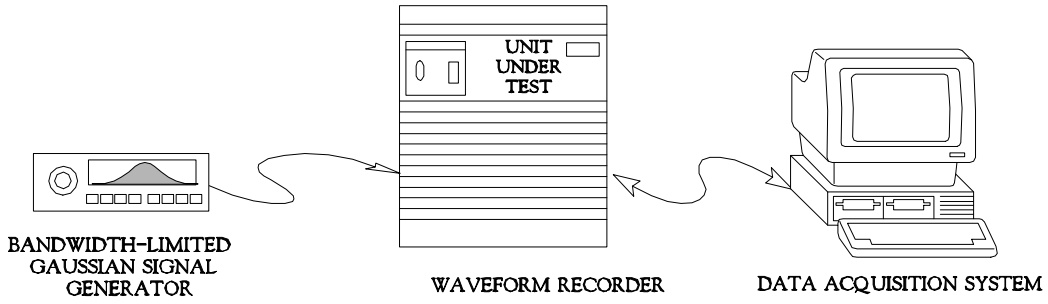
The digitizer passband (3 dB points) should be at least 0.02 Hz to 75% of the Nyquist Frequency.

Reference

Test Procedures (TP) for Seismic Waveform Recorder High Resolution Digitizer Evaluation, V1.05, dated August 9, 1995.

Setup

A bandwidth-limited Gaussian signal generator is connected to the HRD.



Input

Per Test Procedure 2.2.2 - Set the bandwidth of the Gaussian signal generator to avoid aliasing the HRD and to maximize the power within the HRD passband. The amplitude of the generator should be set to the full scale of the HRD without clipping (see Appendix A). Verify the bandwidth and amplitude on the generator per Signal Source Performance Verification Procedure 6.3.2.

Procedure

1. Execute Reference Test Procedures 2.2.2. NOTE: TP 2.2.2 will provide several plots that may be used in later test. Reference TP 4.21 provides the bandwidth results. (NOTE: PDS OUTPUT WILL BE USED IN TP 3.2.5)
2. Measure the lower and upper 3 dB points on the PDS.

Output

Lower and upper 3 dB points on the PDS

Evaluation

Lower 3 dB point is < 0.02 Hz and upper 3 dB is > 75% of the Nyquist Frequency (3.25 Hz).

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.5 T

Requirement Tested

The digitizer attenuation at the Nyquist frequency should be at least 80 dB.

Setup

As in TP 3.2.4.

Input

As in TP 3.2.4.

Procedure

1. As in TP 3.2.4.
2. Measure the difference in power density from the peak to the power density at the nyquist frequency. This value is the attenuation at the nyquist frequency.

Output

The attenuation at the Nyquist frequency.

Evaluation

The attenuation at the Nyquist frequency is > 80 dB.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.6 T

Requirement Tested

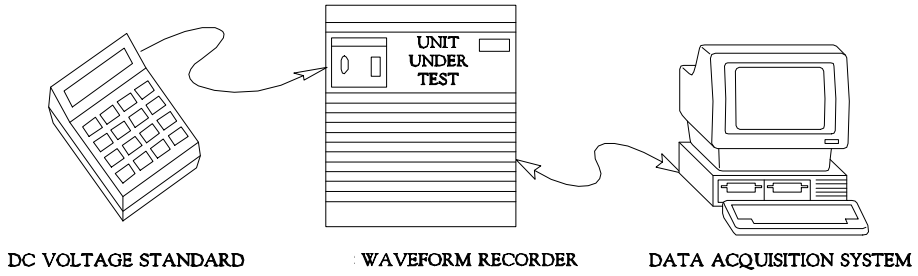
Digitize signal with a sensitivity of at least 2^{19} counts per +/- 10 volts (differential input) +/- 1.0%.

Reference

Test Procedures (TP) for Seismic Waveform Recorder High Resolution Digitizer Evaluation, V1.05, dated August 9, 1995.

Setup

The HRD inputs are connected to a known DC voltage source.



Instrumentation Required:
Datel DCV-350A DC Voltage Standard or equivalent DC voltage source.

Input

A DC voltage source.

Procedure

Execute Reference TP 1.2.

Output

Table of bit-weight, accuracy and dc offset.

Evaluation

Digitizes signal with a sensitivity of at least 2^{19} counts per +/- 10 volts (differential input) +/- 1.0%.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.7 T

Requirement Tested

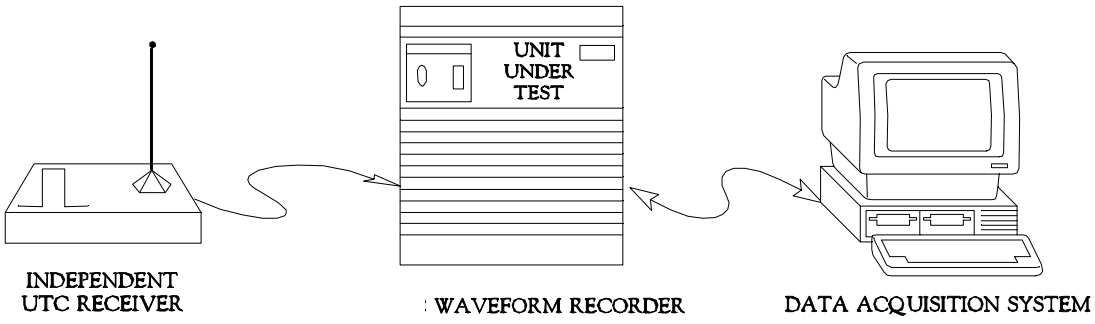
Synchronize the digitizer clock to Global Positioning System (GPS).

Reference

Test Procedures (TP) for Seismic Waveform Recorder High Resolution Digitizer Evaluation, V1.05, dated August 9, 1995.

Setup

The HRD inputs are connected to the slowcode output of an independent running GPS clock or other independent UTC time source.



Instrumentation Required:
Kinemetrics GPS Clock or equivalent.

Input

Slow-code time signal. (NOTE: THIS TEST WILL ALSO PROVIDE THE OUTPUT FOR TP 3.2.8 AND 3.2.9)

Procedure

Execute Reference TP 4.1.

Output

Plot of one-second transitions and corresponding GPS time in the data.

Evaluation

Digitizer clock is synchronized to Global Positioning System (GPS).

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.8 T

Requirement Tested

Time tag the data with GPS time.

Reference

Test Procedures (TP) for Seismic Waveform Recorder High Resolution Digitizer Evaluation, V1.05, dated August 9, 1995.

Setup

See 3.2.7.

Input

See 3.2.7.

Procedure

See 3.2.7.

Output

GPS Time code in the data.

Evaluation

Data are time tagged with GPS time

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.9 T

Requirement Tested

Timing accuracy for 10 sps shall be 1.0 msec or better.

Reference

Test Procedures (TP) for Seismic Waveform Recorder High Resolution Digitizer Evaluation, V1.05, dated August 9, 1995.

Setup

See 3.2.7.

Input

See 3.2.7.

Procedure

See 3.2.7.
NOTE: Reference Test Procedure 5.1 SWR Array Multi-element Relative Transfer Function (ARTF) could be executed to test the inter-element timing.

Output

Time tags of the data from the HRD are analyzed for correct time on the hour, minute and seconds.

Evaluation

Timing accuracy for 10 sps is 1.0 msec or better.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.10 I

Requirement Tested

Provide (Data Acquisition System) documentation to include operations manual, schematics, parts and replacement list to enable repair to the component level.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Inspect documentation delivered by the Data Acquisition System vendor.
2. Documentation should include operations manual, schematics, parts and replacement list to enable repair to the component level.

Output

Documentation includes operations manual, schematics, parts and replacement list to enable repair to the component level.

Evaluation

Documentation includes operations manual, schematics, parts and replacement list to enable repair to the component level.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.11 T/A

Requirement Tested

Provide the filter and digitizer response in the ‘s’ plane pole and zero format.

Setup

Standard field configuration and initialization.

Input

A step function into the digitizer input.

Procedure

1. Measure the digitizer step response as in 3.2.9.
2. Calculate the time domain step response from the transfer function provided by the vendor.
3. Compare the measured and calculated step responses.

Output

The measured and calculated step responses of the digitizer.

Evaluation

The measured and calculated step response compare favorably.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.12 D

Requirement Tested

Collect the following SOH at the each array element:

- DC voltage.
- Internal temperature.
- Tamper Detection such as active switch closures.

Setup

Standard field configuration and initialization.

Input

Standard field configuration and initialization.

Procedure

Demonstrate that DC voltage, Internal temperature, Tamper Detection such as active switch closures are collected at the infrasound enclosure by displaying the appropriate SOH channel on the receiving station PC. Tamper switch may be toggle to change the display.

Output

Displays of DC voltage, Internal temperature, and Tamper Detection such as active switch closures are collected.

Evaluation

DC voltage, Internal temperature, Tamper Detection such as active switch closures are collected.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.13 I

Requirement Tested

Digitize SOH with an 8-bit resolution.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the vendor manual to verify the SOH digitizer module is at least an 8-bit digitizer.

Output

SOH digitizer module model number.

Evaluation

The digitizer is at least an 8-bit model.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.14 I

Requirement Tested

Digitize SOH at 1 sps.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the SOH digitizer to verify that the sample rate is 1 sps.

Output

SOH digitizer sample rate.

Evaluation

SOH digitizer sample rate is 1 sps.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.2.15 D

Requirement Tested

Collect the following meteorological data at the center element:

- Wind speed.
- Wind direction.
- Outside temperature.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Demonstrate that wind speed, wind direction and outside temperature are collected at the center element by displaying the appropriate channels on the receiving station PC.
2. Demonstrate the SOH displays the correct value for the wind speed, wind direction and outside temperature.

Output

Displays of wind speed, wind direction and outside temperature are collected and values are correct.

Evaluation

Wind speed, wind direction and outside temperature are collected and values are correct.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.1 T

Requirement Tested

Authenticate (digitally sign data) at those sites that are collocated with seismic stations. The prototype shall authenticate (sign) data at one element of the infrasound array.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Restart the host station PC software. NOTE: when the PC software is started, 5 blocks of alpha protocol data with the authentication is written to disk.
2. 'ftp' the 5 blocks of alpha protocol data to a PC/WS with an authentication test program that utilizes the DSA public key standard. NOTE: for this test the data was 'ftp' to a Sandia PC.
3. Run the test program to verify the signature of the signed data.

NOTE: This same test program could be installed at the NDC or IDC to verify the data authentication.
NOTE: TP 3.3.1 also provided the data for TP 3.3.3.

Output

Signature verification results on signed data.

Evaluation

The prototype signs (authenticates) data at one element of the infrasound array.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.2 I

Requirement Tested

All array elements should be capable of data authentication (signing data).

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the design of the authentication module to verify all array elements are be capable of signing data.

Output

Array element design.

Evaluation

All array elements are capable of signing data.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.3 T

Requirement Tested

Authenticate using a public key standard.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

See test procedure 3.3.1.

Output

Authentication results on stored/transmitted data.

Evaluation

Data authenticates using the DSA public key standard.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.4 I

Requirement Tested

Generate a private key and distribute the corresponding public key.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect vendor's method for the private key installation and distribution of the corresponding public key.
Since key management has not been agreed to, a manual methodology is acceptable for the private key installation and distribution of the corresponding public key.

Output

Vendors key methodology

Evaluation

A private key is generated and the corresponding public key is distributed manually.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.5 I

Requirement Tested

The authentication module shall be capable of utilizing keys (cryptographic parameters) of variable length.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the vendor's authentication code to verify that it is capable of utilizing keys (cryptographic parameters) of variable length.

Output

Inspection of vendor's code.

Evaluation

The authentication module is capable of utilizing keys (cryptographic parameters) of variable length.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.6 D

Requirement Tested

Provide capability for an active tamper device (switch closure type) at each element.

Setup

Standard field configuration and initialization.

Input

Standard field configuration and initialization.

Procedure

1. Open and close the enclosure lid to open and close the tamper switch.
2. Observe the SOH switch closure display during the same time period on the receiving station PC

Output

1. SOH switch closure display changes status to indicate the switch opening and closing.

Evaluation

SOH switch closure display changes status indicating the switch opening and closing.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.3.7 I

Requirement Tested

Provide capability for at least one passive tamper device (to be provided) at each authenticated element.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the enclosure to assure that it is capable of including a passive tamper device at each authenticated element.

Output

Enclosure is capable of including a passive tamper device at each authenticated element.

Evaluation

Enclosure is capable of including a passive tamper device at each authenticated element..

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.4.1 D

Requirement Tested

Employ error detection, such as CRC, and retransmission protocols for all data from the sensor site to the multiplexer.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Lower the intrasite transmitter power until the lights on the transceiver indicate retransmission of data.
2. Observe the infrasound data at the receiving station for the same time period to verify that the data is continuous.

Output

The data stream at the receiving station should be continuous during the time period.

Evaluation

The data stream at the receiving station is continuous during the time period.
NOTE: This test also serves to test procedure 4.1.1.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.4.2 D

Requirement Tested

Transmit the following digital data from each element to the multiplexer:

- One channel of infrasonic data.
- Three channels of SOH data from each of four array elements.
- Three channels of meteorological data from the center element.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Display the above SOH and meteorological data on the receiving station PC.

Output

The above SOH and meteorological data has been transmitted to the multiplexer.

Evaluation

The above SOH and meteorological data has been transmitted to the multiplexer.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.4.3 I

Requirement Tested

Adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Observe that the data is adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station.

Output

The data is adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station

Evaluation

The data is adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.4.4 I

Requirement Tested

Spread spectrum RF modems are required for this prototype.

Setup

Standard field configuration and initialization.

Input

Standard field configuration and initialization.

Procedure

Inspect the specifications for the RF modems to verify that they are spread spectrum RF modems.

Output

The specifications state that the RF modems are spread spectrum RF modems.

Evaluation

The specifications state that the RF modems are spread spectrum RF modems.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.4.5 I

Requirement Tested

Utilize a separate transmitter to transmit the meteorological data.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Observe that a separate transmitter to transmit the meteorological data has been used.

Output

A separate transmitter to transmit the meteorological data has been used.

Evaluation

A separate transmitter to transmit the meteorological data has been used.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.5.1 D

Requirement Tested

Provide the capability to calibrate sensor and digitizer electronics with a pulse or step signal.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Send a pulse or step signal to the sensor and digitizer.
2. Observe the signal on the display at the receiving station PC.

Output

The signal indicates that the sensor and digitizer has been calibrated.

Evaluation

The signal indicates that the sensor and digitizer have been calibrated.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.5.2 T

Requirement Tested

Provide capability to manually calibrate sensor w/known acoustic source such as a piston phone.

Setup

As in Test Procedure 3.1.1

Input

As in Test Procedure 3.1.1

Procedure need procedure input

Ratio the output of step 6 (mvolts) in test procedure 3.1.1 to Piston-Phone input (μbars).

Output

A calibration value (mvolts/μbar) for each sensor.

Evaluation

Provided a capability to manually calibrate sensor w/known acoustic source such as a piston phone.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.6.1 I

Requirement Tested

Remote infrasound equipment shall operate on 21.6 - 28.8 volts of direct current (DC) power @ 1 amp maximum.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the specification sheets provided with the remote infrasound equipment.

Output

Remote infrasound equipment operates on 21.6 - 28.8 volts of direct current (DC) power @ 1 amp maximum.

Evaluation

Remote infrasound equipment operates on 21.6 - 28.8 volts of direct current (DC) power @ 1 amp maximum.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.6.2 I

Requirement Tested

A DC-DC converter shall be provided at each array element if supplied data acquisition and communications hardware cannot be operated from 24 VDC. This device should have the same operating and environmental specifications as the array element hardware.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

If provided, inspect the specifications to verify that it operations from 24 VDC.

Output

If provided, DC-DC converter operates from 24 VDC.

Evaluation

If provided, DC-DC converter operates from 24 VDC.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.6.3 I

Requirement Tested

Utilize a solar array to provide the DC power or alternately provide the DC from a power supply operating from 110 VAC, 60 Hz or 220 VAC, 50 Hz.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect each array element to verify that a solar array provides the DC power.

Output

A solar array provides the DC power.

Evaluation

A solar array provides the DC power.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.6.4 I/A

Requirement Tested

Provide battery backup to operate the infrasound array for a minimum of 72 hours.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Measure the average current drain (I) for the center array element. .
2. Calculate the average amp-hour usage for 72 hours.

3. Observe the total amp-hour rating on the battery backup.

Output

Amp-hour usage for 72 hours by the center array element and the battery amp-hour rating.

Evaluation

Battery power rating is greater than the center element usage.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.7.1 I

Requirement Tested

Install on a level area of 0.25 km^2 around each sensor (Note: this requirement is too restrictive). Each prototype element shall be installed on an area level within 2.0 m over an area of 0.010 km^2.

NOTE: The prototype requirement is also too restrictive. A better requirement would be -- Each prototype element shall be installed on an area level within 2.0 m over an area of twice the diameter of soaker hoses.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the area around each array element to verify that it is approximately level over an area of 0.010 km^2 (100 meter in any direction).

Output

Visual inspection of area around each array element.

Evaluation

Area around each array element is approximately level over an area of 0.010 km^2 (100 meter in any direction).

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.7.2 I

Requirement Tested

The infrasound prototype shall be installed in an area with some ground cover such as tall grass, shrubs or trees to aid wind noise reduction.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the area around the infrasound prototype for ground cover such as tall grass, shrubs or trees to aid wind noise reduction.

Output

Visual inspection of area.

Evaluation

Area around the infrasound prototype has ground cover such as tall grass, shrubs or trees to aid wind noise reduction.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.7.3 I

Requirement Tested

The prototype shall not be installed on sites with significant average winds.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect available average winds information.

Output

Average winds.

Evaluation

Average winds are not significant.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.7.4 I

Requirement Tested

Sensors shall not be placed downwind of local topographic features that could generate turbulence which would raise the noise level.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the area around the infrasound prototype for topographic features that could generate turbulence which would raise the noise level.

Output

Information on topographic features that could generate turbulence which would raise the noise level.

Evaluation

Area is absent of topographic features that could generate turbulence which would raise the noise level.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 3.7.5 I

Requirement Tested

Sensors shall not be placed in areas with local depressions in terrain (such as bowls) that can allow rain accumulation causing flooding problems.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the area around the infrasound prototype for areas with local depressions in terrain that can allow rain accumulation causing flooding problems such as bowls.

Output

Terrain information

Evaluation

Areas around the infrasound prototype has no areas with local depressions in terrain that can allow rain accumulation causing flooding problems such as bowls.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.1.1 D

Requirement Tested

Employ error detection and retransmission protocols for all data from the sensor site to the multiplexer.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

See Test Procedure 3.4.1

Output

The data stream at the receiving station should be continuous during the time period.

Evaluation

The data stream at the receiving station is continuous during the time period.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.1.2 D

Requirement Tested

Receive the following digital data from the each array elements:

- One channel of infrasonic data.
- Three channels of SOH data.

Setup

Standard field configuration and initialization.

Input

Standard field configuration and initialization

Procedure

Display one channel of infrasonic data and three channels of SOH data from each array element.

Output

One channel of infrasonic data and three channels of SOH data from each array element are displayed.

Evaluation

One channel of infrasonic data and three channels of SOH data from each array element are displayed.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.1.3 D

Requirement Tested

Receive three channels of meteorological data from the center element.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Display three channels of meteorological data from the center element.

Output

Three channels of meteorological data from the center element are displayed.

Evaluation

Three channels of meteorological data from the center element are displayed.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.1.4 I

Requirement Tested

Adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Inspect transmission system for a low-power radio link.
2. Inspect capability for use with buried fiber optic cable or copper cable

Output

Transmission system is adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station.

Evaluation

Transmission system is adaptable for use with low-power radio link, buried fiber optic cable or copper cable to transmit data from the sensor site to the receiving station.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.1.5 I

Requirement Tested

Spread spectrum RF modems are required for this prototype.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the RF modems to verify that they are of the spread spectrum type.

Output

RF modems are of the spread spectrum type.

Evaluation

RF modems are of the spread spectrum type.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.2.1 D

Requirement Tested

Receive 1 channel of infrasound data and 3 channels of SOH data from each of 4 array elements and 3 channels of meteorological data from the center element.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Display 1 channel of Infrasound data and 3 channels of SOH data from each of 4 array elements and 3 channels of meteorological data from the center element.
NOTE: This test procedure also satisfies test procedure 4.3.1.

Output

1 channel of Infrasound data and 3 channels of SOH data from each of 4 array elements and 3 channels of meteorological data from the center element are displayed on the host receiving station.

Evaluation

1 channel of Infrasound data and 3 channels of SOH data from each of 4 array elements and 3 channels of meteorological data from the center element are received.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.2.2 D

Requirement Tested

Output one channel consisting of 4 channels of infrasound data, 3 channels of meteorological and 12 channels of SOH data.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

See TP 4.2.1.

Output

1 channel of Infrasound data and 3 channels of SOH data from each of 4 array elements and 3 channels of meteorological data from the center element are displayed on the host receiving station.

Evaluation

1 channel of Infrasound data and 3 channels of SOH data from each of 4 array elements and 3 channels of meteorological data from the center element are received.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.2.3 N

Requirement Tested

The serial multiplexer could be located at the center element. If so, the temperature requirements for the array elements would apply.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

N/A

Output

N/A

Evaluation

N/A

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.3.1 D

Requirement Tested

Provide the capability to display four channels of infrasound data on a scrolling or buffered snapshot display.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. See TP 4.2.1.

Output

Host receiving station has the capability to display four channels of infrasound data on a scrolling or buffered snapshot display.

Evaluation

Host receiving station has the capability to display four channels of infrasound data on a scrolling or buffered snapshot display.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.3.2 D

Requirement Tested

Provide the capability to display all SOH data in a tabular format and a scrolling or buffered snapshot display.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

See TP 4.2.1.

Output

Host receiving station has the capability to display all SOH data in a tabular format and a scrolling or buffered snapshot display.

Evaluation

Host receiving station has the capability to display all SOH data in a tabular format and a scrolling or buffered snapshot display.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.3.3 D

Requirement Tested

Send all infrasound and SOH data to the NDC in the Alpha protocol.

Setup

Standard field configuration and initialization.

Input

Standard field configuration and initialization.

Procedure

NOTE: Coordinate this test with the NDC point of contact.

1. Initiate the alpha protocol transmission task.
2. Contract the NDC point of contact to verify all infrasound and SOH data are being sent to the NDC in the Alpha protocol.

NOTE: the procedure fulfills test procedure 4.4.1 and 4.4.5.

Output

NDC verifies all infrasound and SOH data are being sent to the NDC in the Alpha protocol..

Evaluation

All infrasound and SOH data are being sent to the NDC in the Alpha protocol.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.3.4 N

Requirement Tested

Provide a capability to respond to NDC/IDC requests for segments of stored data.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

N/A - Not currently included in the Alpha protocol.

Output

N/A

Evaluation

N/A

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.3.5 I/A

Requirement Tested

Provide data storage for 1 month.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Measure the data storage required to store 1 hour of infrasound and SOH data.
2. Calculate the data storage required to store 1 month (30 days) of infrasound and SOH data.
3. Measure the available data storage.
4. Available storage should be greater than required storage.

Output

Available data storage is greater that 1 month.

Evaluation

Available data storage is greater that 1 month.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.3.6 D

Requirement Tested

Store all infrasound data in the CSS format.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1. Display in notepad the CSS 3.0 header file for an infrasound channel. .
2. Verify the CSS format by comparing the header file against the documented format.

Output

Comparison of the stored infrasound data and the CSS format.

Evaluation

Infrasound data compares with the CSS 3.0 format.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.4.1 D

Requirement Tested

Send all infrasound data continuously to the IDC. The prototype shall send all infrasound data continuously to the NDC for retransmission to the IDC.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

See TP 4.3.3.

Output

The prototype is sending all infrasound data continuously to the NDC for retransmission to the IDC.

Evaluation

The prototype is sending all infrasound data continuously to the NDC for retransmission to the IDC.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.4.2 I

Requirement Tested

Utilize ordinary telephone communications (cable or satellite).

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the communications method utilized in the prototype.

Output

Utilize ordinary telephone communications (cable or satellite).Evaluation

Utilize ordinary telephone communications (cable or satellite).

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.4.3 N

Requirement Tested

A packet switch network could be used to transmit data between the receiving station and the NDC.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

1.

Output

1.

Evaluation

N/A

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.4.4 D

Requirement Tested

Employ error detection such as CRC, and retransmission protocols for all data from the receiving station to the NDC.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

NOTE: Coordinate this procedure with the NDC POC.

1. Make/break the TCP/IP connection at the output of the PC.
2. At the NDC observe the data to verify that it is continuous.

Output

Continuous data is received at the NDC.

Evaluation

Continuous data is received at the NDC.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.4.5 D

Requirement Tested

Transmit the following digital data from the receiving station to the NDC:

- Four channels of infrasonic data.
- Three channels of meteorological data.
- Twelve channels of SOH data.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

NOTE: Coordinate this procedure with the NDC POC.

1. Initiate the Alpha protocol transmission to the NDC.
2. The NDC displays the infrasound, SOH, and meteorological data.

Output

NDC displays the infrasound, SOH, and meteorological data.

Evaluation

NDC displays the four channels of infrasound, 12 channels of SOH data, and 3 channels of meteorological data.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.5.1 I

Requirement Tested

Use commercially available 110 volt, 60 Hertz and 220 volts, 50 hertz alternating current (AC) power.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the host station equipment to verify the it operates on 110 volt, 60 Hertz and 220 volts, 50 hertz alternating current (AC) power.

Output

Equipment operates on 110 volt, 60 Hertz and 220 volts, 50 hertz alternating current (AC) power.

Evaluation

Equipment operates on 110 volt, 60 Hertz and 220 volts, 50 hertz alternating current (AC) power.
Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 4.5.2 I/A

Requirement Tested

The host receiving station should utilize a UPS to provide backup power to critical equipment (multiplexer, etc.) for 12 to 24 hours.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

NOTE: A UPS has not been provided since this is a prototype, however, a model has been selected that would fulfill this requirement.

1. Measure the host station equipment power drain.
2. Inspect the selected UPS to verify its power capacity.
3. Verify that the selected UPS is capably of providing backup power to critical equipment for 12 - 24 hours.

Output

Prototype power drain and information on selected UPS.

Evaluation

Selected UPS is capably of providing backup power to critical equipment for 12 - 24 hours.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.1 I

Requirement Tested

The array shall have four elements, Three arranged in an equilateral triangle and the fourth element at the center.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the array installation survey data to verify the arrangement of the infrasound elements.

Output

Infrasound elements are arranged in an equilateral triangle and the fourth element at the center.

Evaluation

Infrasound elements are arranged in an equilateral triangle and the fourth element at the center.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.2 I

Requirement Tested

The array spacing shall 1 km on each side of the equilateral triangle.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the array installation survey data to verify the separation of the infrasound elements.

Output

Array installation survey data to verify the separation of the infrasound elements.

Evaluation

Array installation survey data verifies the array spacing of 1 km on each side of the equilateral triangle.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.3 I

Requirement Tested

Microbaragraph shall operate within specifications over the temperature range of -25.0 °C to 50.0 °C up to 90% humidity, non-condensing.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the microbaragraph specifications to verify the operating temperature range.

Output

Microbaragraph operating temperature range .

Evaluation

Microbaragraph operates within specifications over the temperature range of -25.0 °C to 50.0 °C.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.4 I

Requirement Tested

Remote power system shall operate within specifications over the temperature range of -25.0 ºC to 50.0 ºC up to 90% humidity, non-condensing.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the remote power system specifications to verify the operating temperature range.

Output

Remote power system operating temperature range .

Evaluation

Remote power system operates within specifications over the temperature range of -25.0 ºC to 50.0 ºC.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.5 I

Requirement Tested

Remote equipment (digitizer, communication equipment, etc.) except microbarograph and power system shall operate within specifications over the temperature range of -10.0 ºC to 45.0 ºC up to 90%, non-condensing

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the remote equipment (digitizer, communication equipment, etc.), except microbarograph and power system, specifications to verify the operating temperature range.

Output

Remote equipment (digitizer, communication equipment, etc.) operating specifications

Evaluation

Remote equipment (digitizer, communication equipment, etc.) operates within specifications over the temperature range of -10.0 ºC to 45.0 ºC.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.6 I

Requirement Tested

Remote equipment shall survive storage temperatures of -25.0 ºC to 55.0 ºC.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the specifications to verify the storage temperature for all of the infrasound equipment.

Output

Storage temperature for all of the infrasound equipment.

Evaluation

Remote equipment survives a storage temperatures of -25.0 ºC to 55.0 ºC.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.7 I

Requirement Tested

Remote equipment operation elevation shall be sea level up to 10,000 ft above sea level.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect he remote equipment specifications to verify the operation elevation is at least sea level up to 10,000 ft above sea level.

Output

Remote equipment operation elevation.

Evaluation

Remote equipment operation elevation is at least sea level up to 10,000 ft above sea level.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.8 I

Requirement Tested

Commercial shock and vibration requirements are acceptable.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the equipment specifications to verify shock and vibration specification.

Output

Shock and vibration specification.

Evaluation

Equipment meets commercial shock and vibration requirements.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.9 I

Requirement Tested

The host receiving station equipment shall be capable of operating in a normal office environment.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the host receiving station equipment specification to verify it is capable of operating in a normal office environment.

Output

Host receiving station equipment environmental specifications.

Evaluation

Host receiving station equipment is capable of operating in a normal office environment.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.1.10 I

Requirement Tested

Provide a full (parts and labor) warranty for 1 year for the digitizer and communications systems.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the warranty to verify the vendor provides a full (parts and labor) warranty for 1 year for the digitizer and communications systems.

Output

Vendors warranty on the digitizer and communications systems.

Evaluation

Warranty verifies the vendor provides a full (parts and labor) warranty for 1 year for the digitizer and communications systems.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.2.1 I

Requirement Tested

Standard commercially available products shall be used whenever possible.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the vendors equipment list to verify standard commercially available products were used whenever possible.

Output

Vendors equipment list.

Evaluation

Standard commercially available products were used whenever possible.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.2.2 I

Requirement Tested

Integrate and assemble all equipment in accordance with best commercial practices.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the integration and assembly of all equipment to verify it is in accordance with best commercial practices.

Output

Vendors integration and assembly methods.

Evaluation

Vendor integrated and assembled all equipment in accordance with best commercial practices.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.2.3 I

Requirement Tested

System safety engineering shall be an integral part of the system integration and a primary consideration.

5.2.3.1 The system design shall provide for adequate safety of personnel during system installation, operation, and maintenance. System components shall not be combined in such a manner as to exceed reasonable weight limits.

5.2.3.2 All voltage sources shall be adequately guarded so as not to present a safety hazard to operations and maintenance personnel.

5.2.3.3 The infrasound equipment shall, where practicable, contain transient protection circuits located between all outdoor cables or lines and the infrasound equipment.

- These circuits shall protect equipment against lightning-induced transients, electrostatic charge, or other over-voltage conditions that may appear on the signal and power lines connected to the equipment.
- The protector circuit elements shall dissipate the energy in the over-voltage transient or conduct it to the ground.
- When overloaded, the transient protector elements shall, where practicable, fail in a safe mode.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the system safety engineering to verify:

1. safety of personnel during system installation, operation, and maintenance and weight limits.
2. voltage sources are adequately guarded. and
3. equipment contains transient protection circuits located between all outdoor cables or lines and the infrasound equipment

Output

System safety engineering.

Evaluation

System safety engineering is an integral part of the system integration and a primary consideration.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments

Test Procedure 5.3.1 I

Requirement Tested

Operate unattended for at least one year.

Setup

Standard field configuration and initialization.

Input

N/A

Procedure

Inspect the reliability of analogous systems.

Output

Reliability of analogous systems.

Evaluation

It can be inferred that equipment could operate unattended for at least one year.

Evaluators - TBD

Pass ☐ **Fail** ☐ **Other** ☐

Comments